United States Department of Agriculture
Natural Resources Conservation Service

Airshed Assessment: Topography, Meteorology and Climatology Impacts on Air Quality

What is an Airshed?

- Not a building!
- Not a teenager!
- Different from a watershed
- Bigger than a breadbox

Airsheds

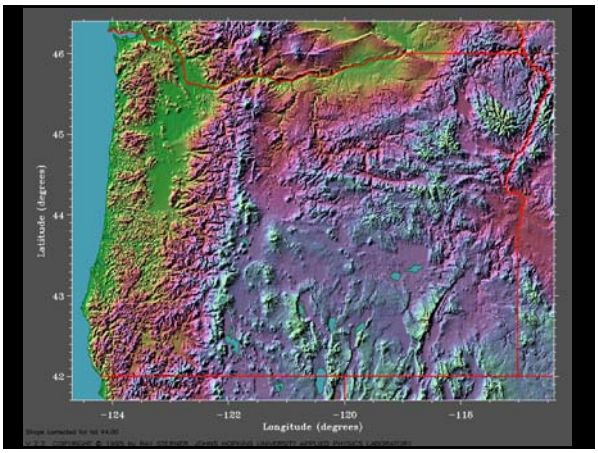
"An ***airshed*** is a part of the atmosphere that behaves in a coherent way with respect to the dispersion of emissions. It typically forms an analytical or management unit. Also: A geographic boundary for air quality standards."

Airsheds

- Scale is important!
  - For some issues, very local airshed (odors)
  - For some issues, regional airshed (ozone)
  - For some issues, global concern (GHGs)
- Think about all of these scales when analyzing potential impacts

Topography-Air Quality Relationships

- Topographic Scale: Airshed Control
- Microclimatic effects
- Valleys: Colder at night (and sometimes even in day in winter); More inversions
- Orientation important w.r.t sun, large scale flow, etc.
- Winds: Up valley during day; Down valley during night



Topographic Analysis

- Examine local to regional topography:
  - Valleys
  - Ridges
  - Slope and Aspect and Scale
  - Sub-airsheds within larger airsheds
  - Analogies to watersheds
- Example websites:
  - www.topozone.com or terraserver-usa.com
  - Google maps

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Landscape/Land Use Characteristics and Air Quality Relationships

- Contribute to microclimatic differences: changes in the BIG 5 (weather factors), w/ consequent AQ impacts
- Landscape: Vegetated, non, type, water
- Landuse: agricultural, urban, industrial
- Types of agriculture: livestock, crops, forestry
- Urban heat islands vs. rural: Night, Winter

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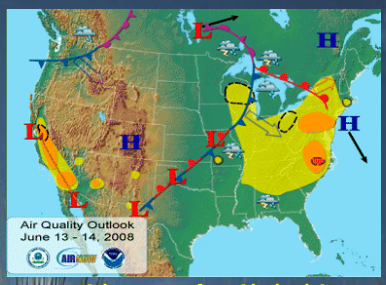
Air Quality, Meteorology and Climatology



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A key part of an Airshed Assessment!

Weather & Climate & AQAC

- Huge factors in air quality and atmospheric change
- Weather: Meteorological conditions as they happen *(Air Quality right now)*
- Climate: Time integration *(Typical and extreme air quality—statistics)*

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Basic AQ Meteorology (and Climatology)

- Meteorological Factors (the **BIG 5**)
  - Temperature
  - Solar radiation
  - Wind (speed and direction)
  - Precipitation
  - Atmospheric moisture content (humidity)

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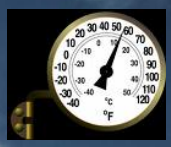
Temperature-AQ Relationships

- O_3: More in warmer temperatures (for given VOC and NO_x values)
- VOCs: More pesticide (and other VOC) volatilization in warmer temperatures
- NH_3: Generally more formed in warmer temperatures



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Vertical Temperature Profile

- Very important for AQ! Issue of ***Stability***
- Typically, temperature decreases with height
- Change of temperature w/ height = "Lapse Rate" (typical rate about 5.5F / 1000 feet)
- Strong surface heating (summer) or "adiabatic warming" (Chinooks) = Large positive lapse rate (can be unstable)
- Strong surface cooling relative to above can lead to ***inversions*** (very stable; almost always high pressure)

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Inversions

- Vertical temperature profile is altered: at some (lower) level temperatures increase with height
- Result in stagnant conditions—little vertical mixing
- Common in colder months, and in valleys
- Associated with high pressure and light winds, though not always

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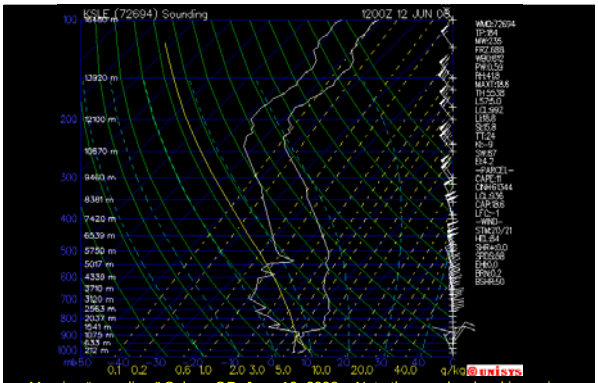

Morning "sounding," Salem, OR, June 12, 2008. Note the very low level inversion (right white line). What is the approx. level of the top of this inversion? Is there a second inversion?

Inversion Case: Donora PA, October 1948

Noon, Halloween, 1948
Principal Pollutants: Fluoride, SO_2, CO, Coal Smoke, Zinc Smelter Dust
20 killed; Hundreds Seriously Injured; 7,000 of 14,000 residents sick

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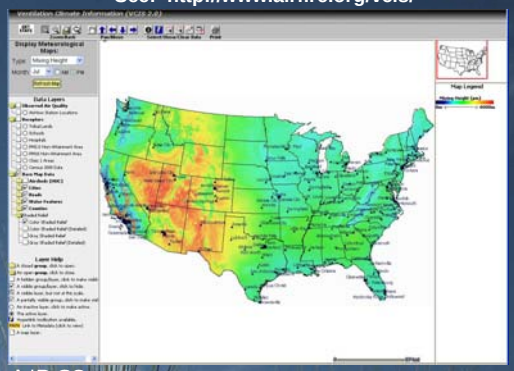
See: http://www.airfire.org/vcis/



Average mixing heights in July, evening

Solar Radiation

- Drives all earth processes, incl. weather/climate
- Directly related to O_3 formation
- May enhance other chemical reactions
  - Provides the energy for the reaction

Wind

- Higher wind speeds typically associated with greater mixing (good) and transport of pollutants, incl. smoke and pesticides (bad)
- High winds: Wind erosion (dust), fire spread
- Very calm conditions not best for chemical application
- Direction important!

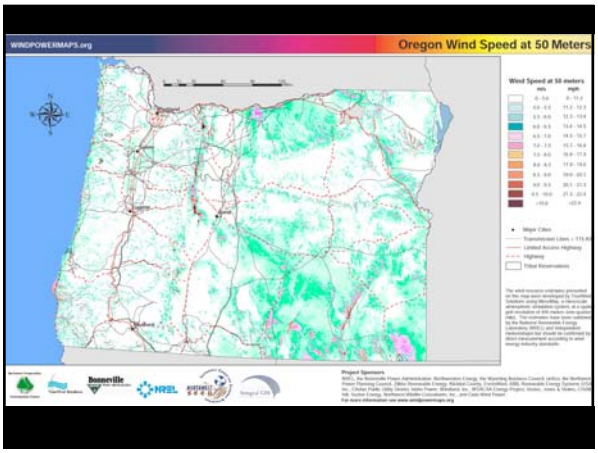
--Especially for odors, PM, chemical drift

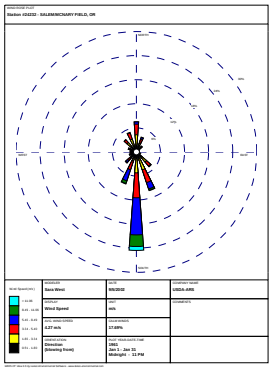
Wind

- Winds generally stronger aloft than at the surface
- Valleys are often the calmest locations
- Winds typically follow terrain orientation
- Air is a fluid—it follows those principles

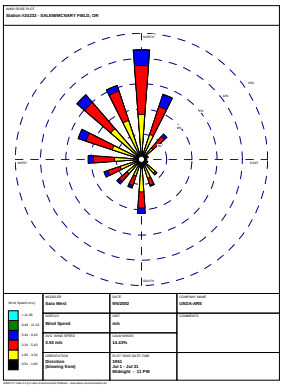
Sources of Wind Data

- Tabular, summarized data
- Wind maps (like OR Wind Resource Map)
- Wind roses:
  http://www.wcc.nrcs.usda.gov/climate/windrose.html
- Winds are always indicated FROM the direction of flow
- Wind roses show directional and speed frequencies (usually 16 directions and 5-6 categories of speed)

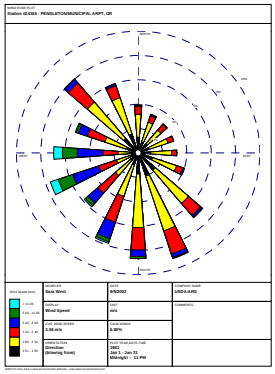




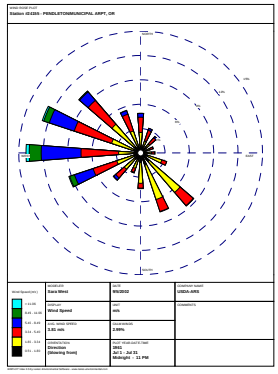
Wind Rose
January
Salem



Wind Rose
July
Salem



Wind Rose
January
Pendleton



Wind Rose
July
Pendleton

Precipitation

- Generally aids air quality:
  - Lowers O_3, PM, Odors → *Scavenging*
- Wet deposition
- Acid rain
- Topography can enhance precipitation

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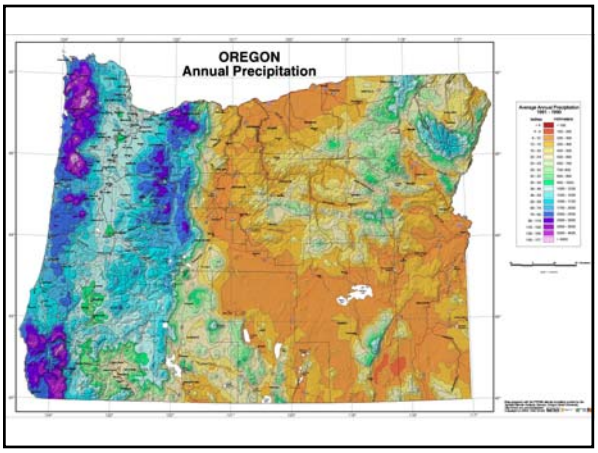

Moisture Content

- Generally reported as relative humidity or dewpoint
- Can impact chemical reactions
- Not necessarily a harbinger of precipitation
- Drier air increases volatilization (spray in moderate to higher humidities)

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Example of Integrating Weather Factors (Wind, Temp., Humidity) into Risk of Spray Drift, by Month for Eugene

Calendar of LOW risk, CAUTION and HAZARD for wind, thermal and inversion drift, Eugene

	J	F	M	A	M	J	J	A	S	O	N	D
Mean wind speed	8	8	8	8	7	8	8	8	7	7	7	8
Low wind drift risk (Prop. <6.5 knots)	42	42	43	44	46	42	39	41	44	51	44	44
Caution (Prop. 6.5-10.5k)	28	31	32	33	34	34	37	34	31	26	33	29
Hazard (Prop. >10.5k)	17	17	18	14	12	14	15	13	13	9	14	15
Mean max temp	47	51	56	61	67	74	82	82	77	65	52	46
RH 10am	80	86	78	71	66	63	57	60	65	80	87	89
RH 4pm	80	73	64	58	54	49	38	39	43	62	79	94
Proportion calm	12	10	7	7	8	9	9	9	11	13	9	11

Other AQ-Weather Considerations

- Air Mass
  - Origin, Constituency, Movement
- Time of year
- Time of day
- System of Influence
  - Location relative to high and low pressure
    - Subsidence and calmer winds under highs
    - Pressure gradient (difference) controls wind speed
- Regional to Local Effects (Valleys, Ridges, Water bodies, etc.)

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In Review…

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Air Quality Psychology

- Ask this about your atmosphere:
  - Are you *unstable*?
  - Are you *hot (angry)*?
  - Are you *turbulent*?
  - Do you feel like you are *going to blow*?

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Integrating Meteorology, Climatology, Topography and Landscape Information into a Local Air Quality Assessment

- Consider the location and the surroundings
- Airshed Assessment:
  - Topographic influences
  - Local to regional landscape and land use
  - Scale of airsheds w.r.t. AQ issues
  - Meteorological factors
  - Air Quality Climatology

It is important to keep these in mind as you do an on-farm AQAC assessment, and develop a conservation plan

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